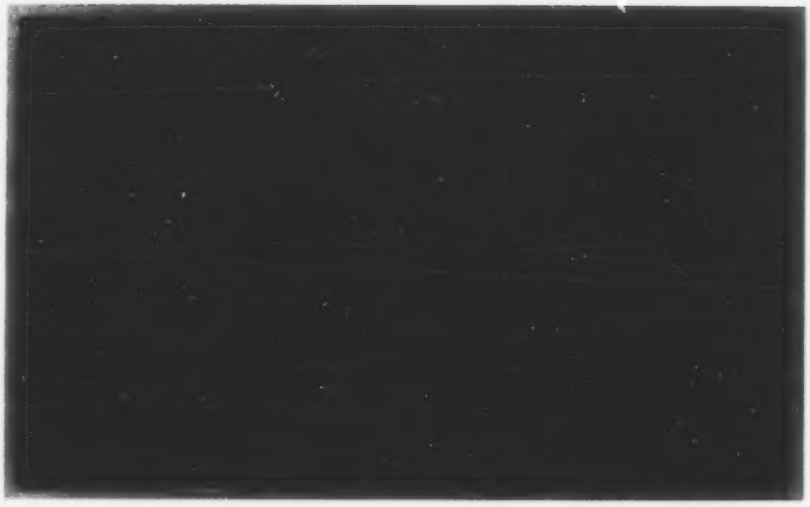
CENTRE DE RECHERCHE
SUR LES TRANSPORTS
(C.R.T.)
CENTRE FOR RESEARCH
ON TRANSPORTATION

UNIVERSITÉ DE MONTRÉAL
ÉCOLE DES HAUTES ÉTUDES COMMERCIALES
ÉCOLE POLYTECHNIQUE



TRAVAIL D'ÉTUDIANT

CENTRE DE RECHERCHE SUR LES TRANSPORTS
UNIVERSITÉ DE MONTRÉAL
C.P. 6128, SUCCURSALE A
MONTRÉAL
CANADA H3C 3J7

TÉLÉPHONE : (514) 343-7575
EMAIL : crt@crt.umontreal.ca
TÉLÉCOPIEUR (FAX) : (514) 343-7121

CRT-861

Transportation and Territorial Development in Singapore Extended Metropolitan Region

by

Jean-Paul Rodrigue

Département de Géographie et Centre de recherche sur les transports, Université de Montréal, C.P. 6128, succursale A, Montréal, Canada H3C 3J7.

Centre de recherche sur les transports — Publication #861

October 1992

Dépôt légal – Bibliothèque nationale du Québec,
Bibliothèque nationale du Canada, 1992

93-01784/

Transportation and Territorial Development in Singapore Extended Metropolitan Region[1]

Jean-Paul Rodrigue[2]
Department of Geography
Centre for Research on Transportation
East Asia Research Centre
Université de Montréal
C.P. 6128, Succ. A
Montréal, Québec
Canada, H3C 3J7

Abstract: Singapore is in a phase of integration of a large economic area including Johor province in Mayasia and the Riau islands in Indonesia. Transportation is a key factor explaining three processes of territorial development in extended metropolitan regions, that is densification, extension and transformation. Densification is the result of a process of spatial accumulation of economic activities within a area. Extension is a space / time collapse enabling economic activities to extend over a large territory. Transformation is a process of change in rural activities towards urban oriented economic production system. Considering the concentration level of transportation infrastructures, Singapore is likely to become the transportation platform of all South-East Asia thus controlling most of the trade and distribution of the spatial accumulation of capital.
Key Words: Transportation, Urbanization, Extended Metropolitan Regions, Singapore.

Résumé: Singapour est dans une phase d'intégration d'un territoire économique étendu incluant la province de Johor en Malaysie et les îles Riau en Indonésie. Le transport est un facteur clé expliquant trois processus de développement territorial dans les régions métropolitaines étendues. Ces facteurs sont la densification, l'extension et la transformation. La densification est le résultat d'un processus d'accumulation spatiale d'activités économiques dans un espace. L'extension est une contraction du temps et de l'espace qui permet aux activités économiques de s'étendre sur un vaste territoire. La transformation est un processus de changement dans les activités rurales vers un système de production économique a caractère urbain. Considérant le niveau de concentration d'infrastructures de transport, Singapour est en voie de devenir la plate-forme de transport de l'Asie du Sud-Est controlant la plupart du commerce et de la distribution de l'accumulation spatiale du capital.
Mots Clés: Transport, Urbanisation, Régions métropolitaines étendues, Singapour.

1. Introduction

Over the last decade, eastern Asia as taken a growing part of international trade and industrial production. Economic development is changing the level, pattern and extension of urbanization in that region. Urbanization in eastern Asia has occurred mainly along coastal areas where accessibility to international trade is optimal. Korea, Japan, Malaysia and Indonesia are good examples countries with a coastal urban system. Therefore, the territorial configuration where urban development occurs is mainly coastal based like South America and Africa. This is quite different from the more continental based urban system that is found in North America and Europe, because most urban development has occurred recently and was more subject to international trade and transportation factors. China is an exception to that rule, but now, Chinese investment policies are axed towards coastal regions because the accessibility of coastal regions to the international market gives a potentially higher productivity of investments made in those areas (Comtois, 1989). Eastern Asian cities were also strongly influenced by colonial incorporation, especially by Britain (China, Malaysia), France (Indochina) and The Netherlands (Indonesia).

Singapore represents a particular case of coastal urbanization in South-East Asia. Established at the beginning of the 19th century as a port of call for the British trade in East Asia, Singapore became an entrepôt. Its strategic location at the end of the strait of Malacca, has put Singapore at the crossroads of important maritime routes between economic blocs, mainly Europe and Japan. From an entrepôt, Singapore has emerged in the 60s as an important manufacturing centre and transportation hub better known as one of the "Four Dragons" with Hong Kong, Korea and Taiwan forming the Newly Industrialized Countries (NICs).

---

[1] This research is supported by a grant from the Social Sciences and Humanities Research Council of Canada, grant #752-91-0318.

[2] The author would like to thank Terry McGee for helpful comments.

As a city-state, Singapore depends highly on international trade and on its accessibility to the international market for economic growth. In fact, one third of Singapore's Gross Domestic Product (GDP) is based on trade, mostly sea-borne. With limited space available, the authorities of Singapore have practiced efficient urban planning policies, constraining industrial development in specific zones and equipping the city-state with modern transportation infrastructures. However, due to those policies it appears that urban development has reached a state of saturation because large areas must by reserved for housing, water catchment, intermodal transportation and conservation in order to convey a reasonable level of self sufficiency in an environmental conscious society. Singapore faces an increasing economic and transportation demand, but there is very limited space for expansion within the city-state even with land reclamation. Presently, we observe in Singapore a process of densification of land use, a decline of the secondary employment sector and a strong growth of the tertiary employment sector. The main goal of Singapore is to become a financial, service, communication and transportation centre for all South-East Asia. All those processes occur in a context of intense urban restructuring, important investments in transportation infrastructures (peoples, goods and information) and industrial relocation. The resulting territorial structure is no longer a single metropolitan area inside a city-state, but an intensive movement network of goods, people and information over a large territory exceeding the city-state and composed of several urban centres as well as production units in rural areas: the Singapore extended metropolitan region.

The objective of this paper is to identify transportation factors affecting territorial development in Singapore Extended Metropolitan Region (EMR) and to address the notion urbanization. We suggest that Singapore is in a phase of integration of a large economic space including southern Malaysia (Johore) and northern Indonesia (Riau) and that transportation is a key factor in the emergence of extended metropolitan regions. We first present the location of Singapore in the international transportation system by underlining the current effects of global factors in Singapore's transportation system. Secondly, an assessment of the territorial development of the Singapore extended metropolitan region is undertaken. Thirdly, a discussion on transportation / land use development strategies for Singapore is made. The paper will then conclude on the role of transportation in the territorial development of extended metropolitan regions in general and of Singapore in particular.

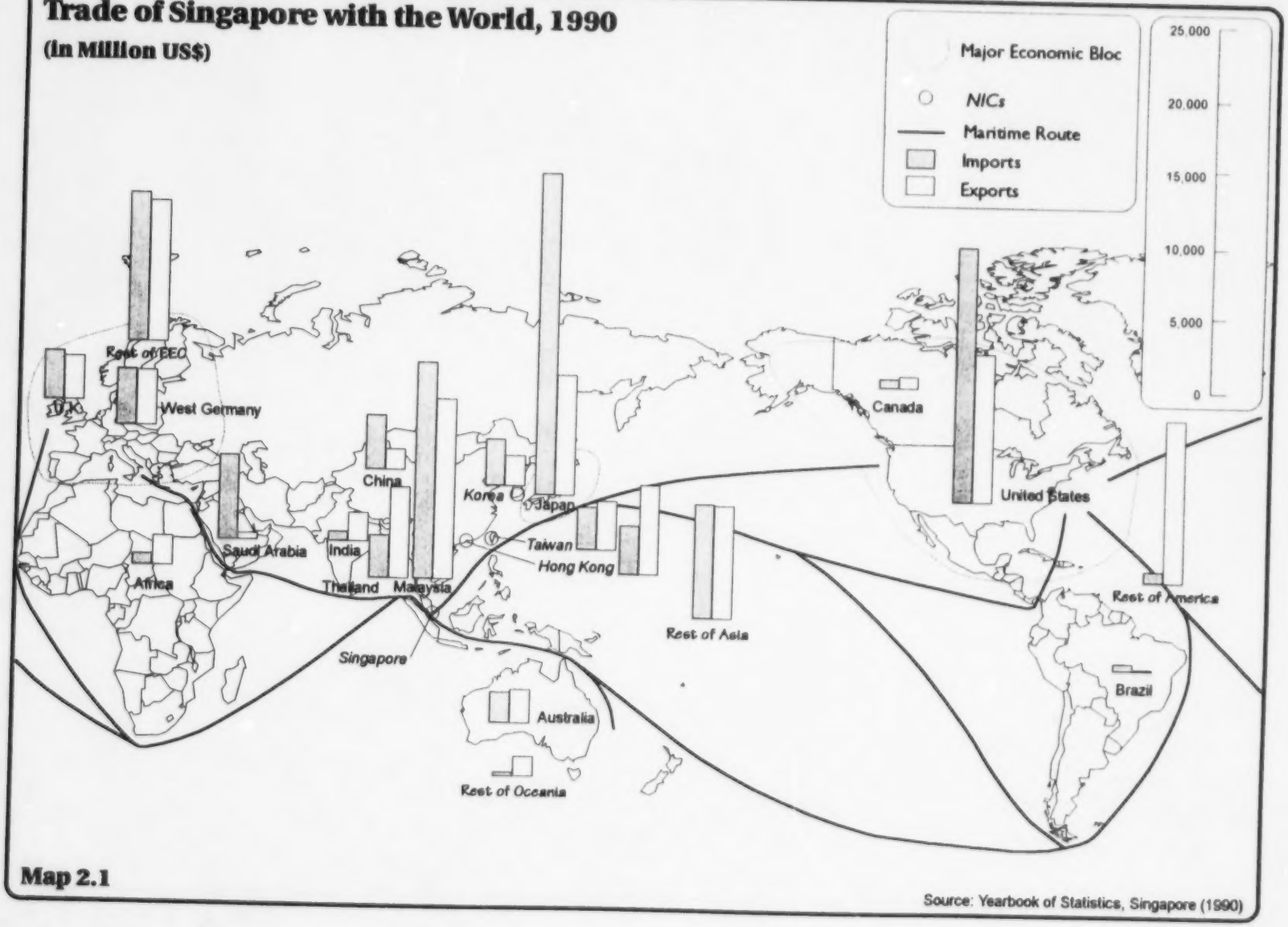
2. Singapore in the International Transportation System

The main tendency of the international transportation system is an adaptation of nodes to the international division of production. With changes in technology, this has tended to imply fewer transportation nodes, larger shipments and high capacity transportation chains to achieve economies of scale. Each node must develop an efficient regional transportation network in order to coordinate and transit the production of a vast territory and maintain or increase its importance at a global scale. The importance of a transportation node can be measured by its position relative to other transportation nodes. A set of nodes is a transportation chain linking economic areas. If a node has efficient intermodal infrastructures, it probably could strengthen its position within the transportation system by being a point of origin, destination and transit of large quantities of goods, people and information. Therefore, transportation is a general measure of the efficiency of a spatial system. Transportation, more precisely intermodal infrastructures, do not cause economic development, but is a predominant factor, among others, favouring the spatial accumulation of capital, labour and infrastructures. In some cases transportation infrastructures precede investments, in others they follow investments, and sometime they are concomitant to them.

As a city-state with limited raw resources, Singapore has created and maintained strong linkages with other economic areas as well with its region in order to support its economic viability and its service sector. To underline the situation of Singapore in the international transportation system we present the spatial distribution and the nature of its trade. Map 2.1 shows the trade of Singapore with the world and the main maritime routes. Singapore is at the crossroad of main maritime routes between important economic blocs and at the centre of an emerging economic area: the Pacific rim. Economic blocs represent countries that have strong economic linkages, but not necessarily a cultural homogeneity. Two major (North America and Japan) and four minor (Oceania, ASEAN, China and South America) economic blocs are adjacent to the Pacific Rim. To this, we must add the four NICs that are separate highly dynamic economic entities that have made heavy investments to become regional intermodal centres. Therefore, the Pacific Rim is not a homogenous economical bloc, but rather a set of more of less integrated economic areas. With the growth of trade, transportation linkages, economic development and more political stability, it is likely that the Pacific Rim will be a more coherent economical (if not cultural) area than it is today.

Trade of Singapore with the World, 1990

(In Million US$)



Map 2.1

Source: Yearbook of Statistics, Singapore (1990)

The articulation points of that complex economic area are likely to be intermodal centres that will control the flows and the spatial accumulation and distribution of economic activities at a regional level. Major articulation points for the Pacific Rim are West Coast of the United States (Los Angeles and Seattle), Japan, Korea, Taiwan, Shanghai and Hong Kong. Singapore is such a centre for South-East Asia.

2.1 International Trade

Overall, the trade balance of Singapore is slightly negative (-14,599.9 M S$ in 1990), but statistics do not account for services exports (like financial and management) where Singapore has shown an important growth of its GDP. In 1990, manufacturing accounted for 29.1% of Singapore's GDP, while trade, transport, communications and finance accounted for 63.2% (17.3%, 13.1% and 32.8% respectively). Service activities are now far more important than manufacturing in Singapore's economy. The trade of Singapore is mostly regional (see map 2.1), especially with Japan and Malaysia, but strong linkages exist with the United States and Europe, mainly for exports. The regional trade of Singapore with Asian countries represents 58.6% of the total trade in 1990 and the trade balance is highly negative, especially with Japan (-13844.7 M$ in 1990). A preliminary explanation of that situation is that Singapore is a regional hub for trade, a transactional centre and a growing consumption centre selling and distributing many Japanese goods.

Table 2.1: Singapore: Value of Imports and Exports by Commodity, 1990 (in M$)

Commodity	Imports	Exports	Domestic Exports	% of Exports
Food, Beverages, Tobacco, Animal & Vegetable Oils	6,493.0	4,882.7	1,931.1	39.5
Raw Materials[1]	2,371.1	2,914.6	460.1	15.8
Petroleum & Fuels	17,398.9	17,295.3	17,136.7	99.0
Chemicals[2]	8,440.5	5,970.1	3,618.6	60.6
Manufactured Goods[3]	14,167.5	6,651.3	2,126.9	32.0
Machinery & Transport Equipment	49,065.1	47,732.6	32,351.8	67.8
Miscellaneous Manufactured Articles[4]	10,450.2	8,499.7	4,866.4	57.2
Other	1,419.6	1,259.7	262.5	20.8
Technological Goods[5]	17391.7	28,593.1	21,997.0	76.9
Total	**109,805.9**	**95,206.0**	**62,754.1**	**65.9**

[1] Includes timber and rubber.
[2] Includes Chemical Compounds, Plastic Materials and Medicinal Products.
[3] Includes Textile Manufactures, Non-metal Mineral Manufactures, Iron & Steel, Metal Manufactures, Paper & Paperboard & Related Articles.
[4] Includes Scientific & Optical Instruments and Watches & Clocks.
[5] Includes telecommunication apparatus, office machines, scientific & optical instruments and printed matters.
Source: Yearbook of Statistics (1990), Singapore, Department of Statistics.

Table 2.1 presents the trade of Singapore by commodity. The percentage of exports of domestic production can be used as a measure of concentration of the regional production in Singapore for each industrial sector. The higher it is for a commodity, the more the industrial production of that commodity is concentrated in Singapore. We suggest that Singapore is an efficient transportation centre that transit regional resources and goods towards other economic areas, and thus controlling the regional production. This assumption is supported by the fact that domestic exports account only for 15.8% of the total exports for raw materials and 39.5% for food & related products. 34.1% of the value of exports of Singapore are re-exports. In fact, Singapore is importing more manufactured goods than it is exporting (12.9% versus 7.0% of its trade in 1990) and only 32.0% of exports in that sector are domestic,

confirming changes in the nature of the industrial structure towards a regional distribution of the production in specific sectors. Technological goods like telecommunication apparatus and office machines now account for 45.6% of Singapore's domestic exports and 76.9% are domestically produced. Technological goods have the highest level of domestic production after petroleum. It is important to understand that regional resources can greatly vary in nature according to their origin. For instance, the high value of imports from Japan (map 2.1) suggests that they are mostly electronic components and processed of semi-processed goods, while the trade with other asian countries like Indonesia, the Philippines or China is most probably to involve less sophisticated goods and raw materials like oil, food, timber, textiles and in some extent manufactured goods.

Figure 2.1 shows the percentage shares of Singapore's imports and exports by country. It appears that Singapore's value of trade with South-East Asian (ASEAN[3]) countries have considerably dropped relatively to other parts of the World since 1965, but it stills count for an important part of the trade (17.1% of imports and 22.0% of exports). This can be interpreted has a gradual raise of added value of Singapore's exports towards developed countries of the Pacific Basin Five (USA, Canada, Japan, Australia and New Zealand) and few changes in the nature of trade with ASEAN countries, which involve petroleum products for a great part. Individually taken, trade (exportations as well as importations) with Japan, USA, and Asian NICs have sensibly grown. Imports from Saudi Arabia present a special case. At the beginning of the 80s, Singapore was highly dependant from Saudi Arabia for oil supply. But since then, Singapore has shifted towards Malaysia, Brunei and Indonesia as major oil suppliers for several reasons, but mainly proximity and diversification of supply.

2.2 The Port of Singapore

The prominent position of Singapore in the international transportation system (see map 2.1) is mainly attributed to the efficiency of its port as an intermodal centre with deep water berths. Singapore has benefited from its strategic position and developed intermodal infrastructures and related activities. As a result, Singapore is the biggest port in the World in terms of total tonnage of Ships. In Asia, the port of Singapore ranks first in containers handled, not far in front of Hong Kong, Kobe and Kaohsiung.

Table 2.2: Singapore: Sea-Borne Cargo Handled, 1965-1990 (in thousand freight tonnes)

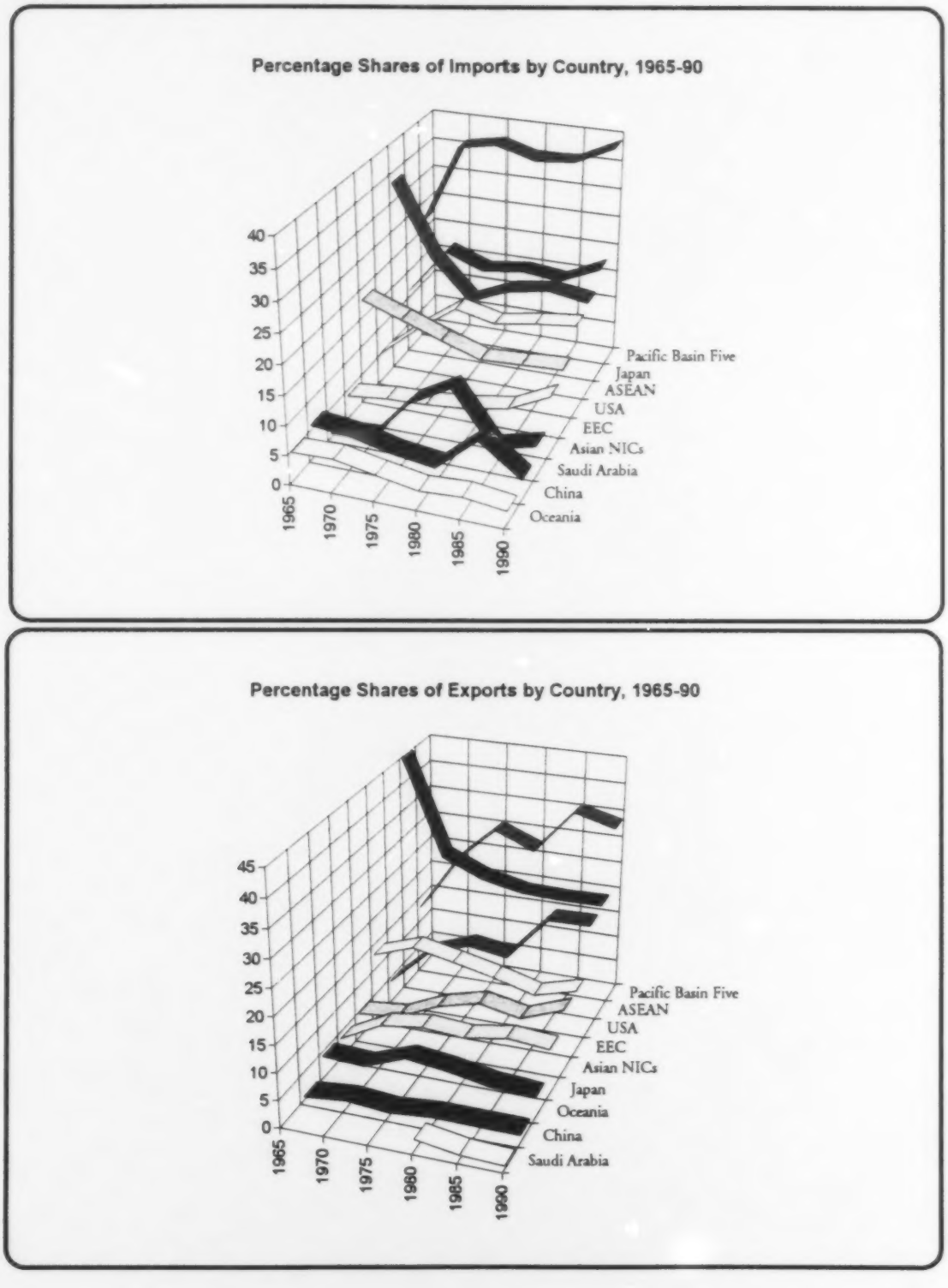
		Unloaded			Loaded		
	Total Containers	General and Bulk[1]	Mineral Oil	Total	General and Bulk[1]	Mineral Oil	Total
1965	0	4596	9279	13875	2385	5887	8272
1970	0	6359	20919	27278	4160	12096	16256
1975	191600[2]	9452	23580	33032	5329	13738	19067
1980	12550	18490	31633	50122	15318	20859	36178
1985	23862	23656	38430	62086	18569	25181	43750
1990	76631	52888	53335	106223	47996	33571	81567

[1] Including containers.
[2] In twenty foot equivalent unit.
Source: Chia Lin Sien (1989); Yearbook of Statistics 1990, Singapore, Department of Statistics.

Table 2.2 shows the evolution of the activity of the port of Singapore since 1965. The share and volume of mineral oil handled over the total cargo is very important (46.3% in 1990). Petroleum products account for approximately 25% of the value of trade. This is related with the fact that Singapore is the third largest refining centre in the World, with a capacity of 1.1 million barrels per day (Fesharaki, 1989). It is obvious that the domestic demand does not justify that capacity even if Singapore is a refuelling centre for a large fleet. Singapore serve as an oil refining and distribution centre for all South-East Asia. Countries like Malaysia and Indonesia are important

[3] Brunei, Indonesia, Malaysia, Philippines and Thailand.

Figure 2.1: Singapore's Imports and Exports



oil producers, but they lack the capacity, skilled labour and technology to process all their oil production. With its efficient port infrastructures, deep water berth and shore based refineries, Singapore can accommodate large tankers, process the oil and re-export it. Over that aspect, table 2.1 shows that 99.0% of petroleum exports are domestic exports and that Singapore exports approximately that same value of petroleum than it imports (17,398.9 versus 17,295.3 M $S in 1990). Refineries in Singapore are able to synthesis specific oil products that other refineries in the region are unable to. Its strategic position between oil producing countries in the Middle East and big consumers like Japan, Hong Kong, Korea and to some extent Western United States, has favour the development of Singapore's petrochemical industries. Considering the oil consumption of the Singaporian economy, which can be grossly calculated by subtracting the unloaded oil by the loaded oil on table 2.2, this suggests that 37% more value was added to oil be refining in 1990.

The spectacular growth of containers handled in Singapore (51% per annum) underline its importance as a load centre (see table 2.2). With an average turn-around time of 20 hours and an average waiting time of 7 hours (in 1986), Singapore is a major hub point for the round-the-world liner shipping introduced in 1984 by Evergreen Line. This service uses very large, high speed container vessels that require a maximum handling capacity of the port intermodal infrastructures an a limited number of ports of call. This means that Singapore is the hub centre for the handling and shipping for all the containers in the region. The regional accessibility that the intermodal transportation system of containers offers is tremendous. The strong growth of containers can also by used as an indicator of a structural shift in the economy. Considering the nature of freight carried through containers, that is consumption goods with high added value, Singapore is not only producing more goods of that type, but also spreading this type of production over a large territory.

2.3 Air Transportation

Air transportation is a key factor of the integration of a spatial system to the international transportation system and more likely to the transactional system. A growth in the service sector, especially in financial services is always accompanied by a growth of the air traffic. Airports are therefore a fundamental intermodal infrastrtucture for transactional related activities.

Table 2.3: Air Traffic of Singapore, 1980-1990

	Aircraft Landing	Passengers Arrival	Departure	In Transit	Air Cargo[1] Discharged	Loaded
1980	37,956	3,140,723	3,151,032	1,002,794	90,713	91,062
1985	36,600	4,323,587	4,397,908	1,135,335	167,388	132,631
1990	48,803	7,237,233	7,166,347	1,217,178	324,157	299,684

[1] In tonnes.

Source: Yearbook of Statistics 1990, Singapore, Department of Statistics.

Table 2.3 indicates that in 1990 Singapore's airport accommodated approximately 40,000 passengers a day of which 3,500 were in transit. While the number of passengers in transit have remained relatively stable, the number of arrivals and departures have more than doubled since 1980 and air cargo has more than tripled. Thus the Singaporian economy generates by itself more air traffic. This traffic is highly linked with transactional activities like management and finance, and the growth of air traffic shows that Singapore is likely to be characterized by a more service oriented economy.

2.4 Telecommunications

The transformation of the Singaporian economy towards a more service oriented sector requires the growing use of information and related technologies for its transmission like telecommunications. For instance, the number of international phone calls have grown from 3.5 million in 1980 to 73.9 million in 1990 (a 2011% increase). At the same time that Singapore is becoming a major hub in South-East Asia for the transportation of goods and people, the city-state is investing massively in modern telecommunication infrastructures.

2.5 Assessment

We suggest that the simultaneous growth of goods, people and information transportation has a strong synergetic effect on all aspects of the economy and transform the territorial structure of a metropolitan area. The position of Singapore in the international transportation system can be summarized by the following points: 1) Emergence of Singapore as a regional transportation hub and intermodal centre. 2) Changes in patterns and nature of trade. 3) Growth of containers transportation. 4) An important oil refining and distribution centre. 5) Air transportation and telecommunication centre.

3. Territorial Development of the Singapore Extended Metropolitan Region

3.1 Theoretical Aspects of Large Scale Urbanization

Large scale urbanization is a process that have began in the 50s and involves the distribution of urban activities over a large territory, this includes transaction, production, transportation and housing. The result is a fundamental change on the spatial structure of what we consider a city. Basically the city structure has evolved from a nodal to a multi-nodal structure (Huth, 1983). We advance that multi-nodal cities are within a multi-nodal urban system where transportation infrastructures converge at nodes. The concept of a multi-nodal urban system must be understand as a regional division of economic activities, mainly the production system. Three general processes of structural changes have permitted large scale urbanization and the emergence of a multi-nodal urban system. We define those process as *extension*, *densification* and *transformation* of land use (see figure 3.1).

1) Extension of urban space use is basically a space / time collapse permitted by the development of transportation infrastructures and related technologies. Travel time as well as travel costs have considerably decreased, and many activities that where dependant on location of factors, like labour, resources and/or market are no longer limited to labour pools, extraction sites and/or central areas and can be located almost anywhere as long as they have access to an efficient transportation network. Extension also expand the average commuting distance in an urban area. The road network is the transportation mode that have most affected the spatial structure of occidental cities through extension, and it is starting to favour extension in Asian cities. The notion of extension raises the problem of the spatial cover of an urban area. Limits of large urban areas are indeed fuzzy (Rolland-May, 1987) and it is difficult to tell where a city ends and where another spatial entity (urban or rural) begins.

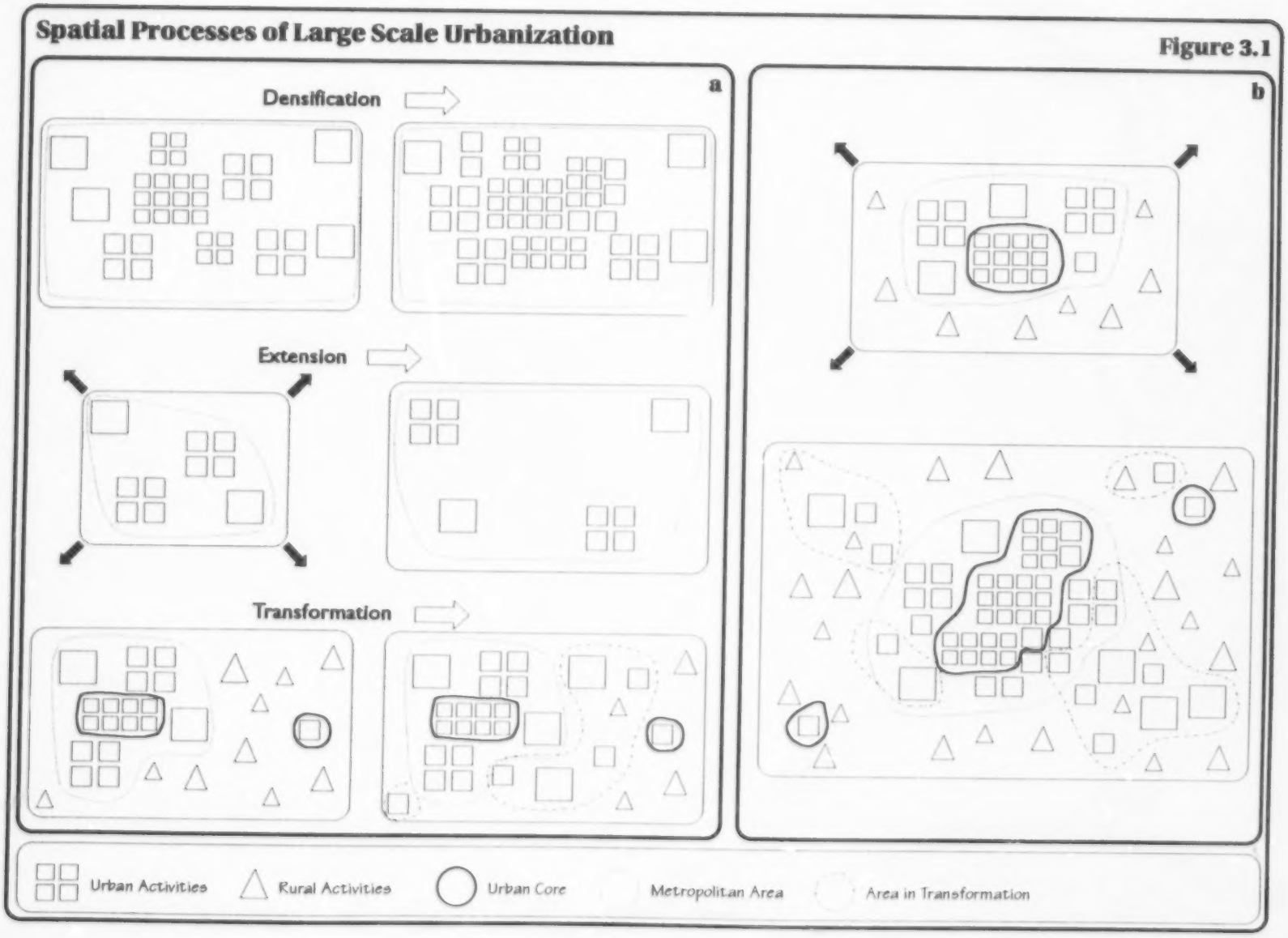
2) Densification of land use is the result of a process of spatial accumulation of economic activities, that is placing more infrastructures (transaction, production, transportation and housing) within the same area. The objective is to generate more capital with the same surface through higher levels of productivity. This requires high level of investments on dense urban infrastructures in order the raise the utility value of land use, that is the general economic output per unit of surface. The densification process involves the transformation of urban activities to an higher level of productivity. Activities that do not produce enough capital are "expelled" to places where their establishment will raise the capital generated per unit of surface. Surplus capital generated by economic activities can be reinvested in the densification process, that is raising the density of land use, or invested outside where they will produce a transformation of the spatial structure. Densification is well explained by land rent theories (Thrall, 1987).

3) Transformation is a process of change in rural activities towards urban oriented economic production. It is a process similar to the densification, but instead of a densification and transformation of urban land use, there is a transformation of non urban land use (mostly rural) in activities that are a part of the urban production system. Transformation can also include a shift in rural production towards specific demands of an urban market, like vegetables, fruits and leisure. Transformation is mostly the result of the extension and densification of urban areas. For instance, with new transportation infrastructure, an area that where previously lightly affected by a nearby city can find itself in the middle of a strong process of transformation with the implementation of industries and a shift in rural production.

On figure 3.1a, extension, densification and transformation are represented individually in order to simplify the spatial processes involved. In reality those processes never occur alone, but concomitantly. We define urban core as the densely built urban area and metropolitan area as the territory covered continuously by urban activities. We must understand that the limits of a metropolitan area are not absolute in the sense that it is difficult to tell when the city end. The overlay of those process produce figure 3.1b, that is a simplified theoretical representation of aspects of large scale urbanization forming an extended metropolitan region.

Spatial Processes of Large Scale Urbanization

Figure 3.1



It is important to understand that those three processes are not unidirectional, that is a counter process can occur for each one. *Contraction* can result if transportation costs sharply increase on an over extended spatial system. A *sparser density* of land use happen if an area lose its general level of productivity relatively to other regions. The spatial accumulation of capital is therefore negative. This is the fate of a number of areas in the Northern Midwest of the United States. The *re-transformation* of areas follows a local loss of accessibility from a contraction process. This implies an abandon of some industrial and rural activities with some areas becoming unused altogether.

3.2 Definition of Forms of Large Scale Urbanization

The territorial development of Singapore raises the question of the definition of the new emerging spatial pattern of large scale urbanization processes. To define recent aspects of urbanization in East-Asia, three basic definitions have been proposed: 1) Megalopolises; 2) Mega-urban regions; and 3) Extended metropolitan regions. We will here review those definitions.

3.2.1 Megalopolises

The concept of megalopolises was first introduced at the beginning of the 60s to describe urbanization in the Northeastern seaboard of the United States (Gottmann, 1961). The megalopolis is an advanced form of urban transition. The resulting spatial system is a set of metropolitan areas (the inner city, the suburbs and satellite towns) linked by an efficient transportation network, mostly rail and road, over a large territory. More recently, air transportation have started to play an increasing role as the economic activities shifted towards a more technological and transactional nature (Castells, 1985). The inter-metropolitan areas of that urban systems are characterized by a low population density and very few rural activities. Urban development occur along transportation axes, particularly at highly accessible places like freeway interchanges. It has been demonstrated that similar spatial process occurred in Europe (Rhine-Rhur) as well as in Japan (Tokyo-Osaka or Tokaido, Rimmer, 1986). Megalopolises are considered as complex urbanized entities where inter-metropolitan areas do not play an important role in the economic production.

3.2.2 Mega-Urban Regions

Following the emergence of a new spatial form of urbanization in East-Asia, the notion of mega-urban region was introduced. The mega-urban region is similar to the megalopolis but the main fundamental difference lays in the nature of inter-metropolitan areas. In places where there is the emergence of mega-urban regions, inter-metropolitan areas are characterized by a high density of population and land use, even reaching occidental urban densities. While economic growth in megalopolises occur only in metropolitan areas, urbanization in a number of East-Asian countries happen as well as in metropolitan areas and in rural areas. Urbanization has strictly involve densification and extension of occidental cities with limited transformation, while in East-Asia an important process of transformation of rural areas as well as the densification and extension of existing cities is occurring. The transformation of rural areas has created a new spatial form that is not urban nor rural, but characterized by an intense mixture of industrial and rural activities, shifts in labour occupation and a growing transportation demand. McGee (1991) has defined those areas by the term *desakota* where *desa* means town and *kota* village. Mega-urban regions are composed of highly linked extended metropolitan regions.

3.2.3 Extended Metropolitan Regions

The Extended Metropolitan Region (EMR) is a urbanized space of smaller scale than the mega-urban region. Densification, extension and transformation of space is also occurring, and we suggest that those processes mainly occur at that level. The EMR is the smallest scale of analysis to understand large scale urbanization. When the zone of extension of an EMR reach the zone of extension of another EMR, the resulting spatial pattern is likely to be a mega-urban region. Instead of an intense network of metropolitan areas, the EMR has only one main metropolitan centre with a set of smaller cities structured by a relatively radial transportation network. The EMR is a growth pole that distribute the process of spatial accumulation within its surrounding space as well as to the international urban system in order to achieve economies of production. The radial transportation network of the EMR with most of the time a main transportation corridor rests on its capacity to convey movements of goods,

people and information for all its economic space. This put the emphasis of the intermodal capacity of the hub, that is the main metropolitan area. Intermodality occurs mainly with the maritime transportation system, so coastal EMR are likely to be the most developed.

Figure 3.2 presents the theoretical spatial pattern of an extended metropolitan region. The EMR is basically composed of four types of spatial entities performing specialized economic activities: 1) The metropolitan area; 2) Urban centres; 3) Desakota areas and 4) rural and unsettled areas.

1) A metropolitan area is where transaction, production and transportation activities of high order are concentrated. Transaction implies tertiary and quaternary activities like financial services, telecommunications and high level educational institutions. The purpose of the transaction related activities is to manage and control the production, resources and capital of a vast territory. Production related activities are oriented towards high added value goods requiring skilled labour. Transportation activities transit the production of the EMR to the international urban system thus making the metropolitan area the hub of the whole EMR. Ports are the main infrastructure for that purpose, but airports play an increasing role has the economic activities of the metropolitan area become more transactional related. The metropolitan area is an important consumption centre of all kind of goods and information produced by the EMR and coming from the international market. The metropolitan area is increasingly exchanging with the international market goods, people, information, resources, investments and capital, and also distributing goods and resources, managing the telecommunication network, performing investments, using the EMR as a leisure zone (movements of people), transiting goods and resources from the EMR (re-exports), accumulating capital (bank assets), and attracting people (for shopping and immigration) and labour (permanently or temporary).

2) A set of urban centres is performing some production, transportation and administrative activities. The production is mostly labour intensive and entirely exported towards the metropolitan area. Some centres can exchange goods and resources with the international market via a small intermodal centre, but the exchanges are mostly of small scale and of a very specific nature.

3) A transforming rural area having the characteristics of *desakota* where industrial production and rural extraction exists. There is a growth of movements of people, labour and goods. This space is highly affected by the extension of the urban area.

4) Rural and unsettled areas that area experiencing changes in agricultural extraction technologies that free labour. This labour either migrate to production centres of engage in non-rural activities and thus gradually transforming the space into *desakota* areas. These areas are within the zone of extension, but are less attractive to investments because they are not well served by transportation infrastructures and/or few opportunities for investments are present.

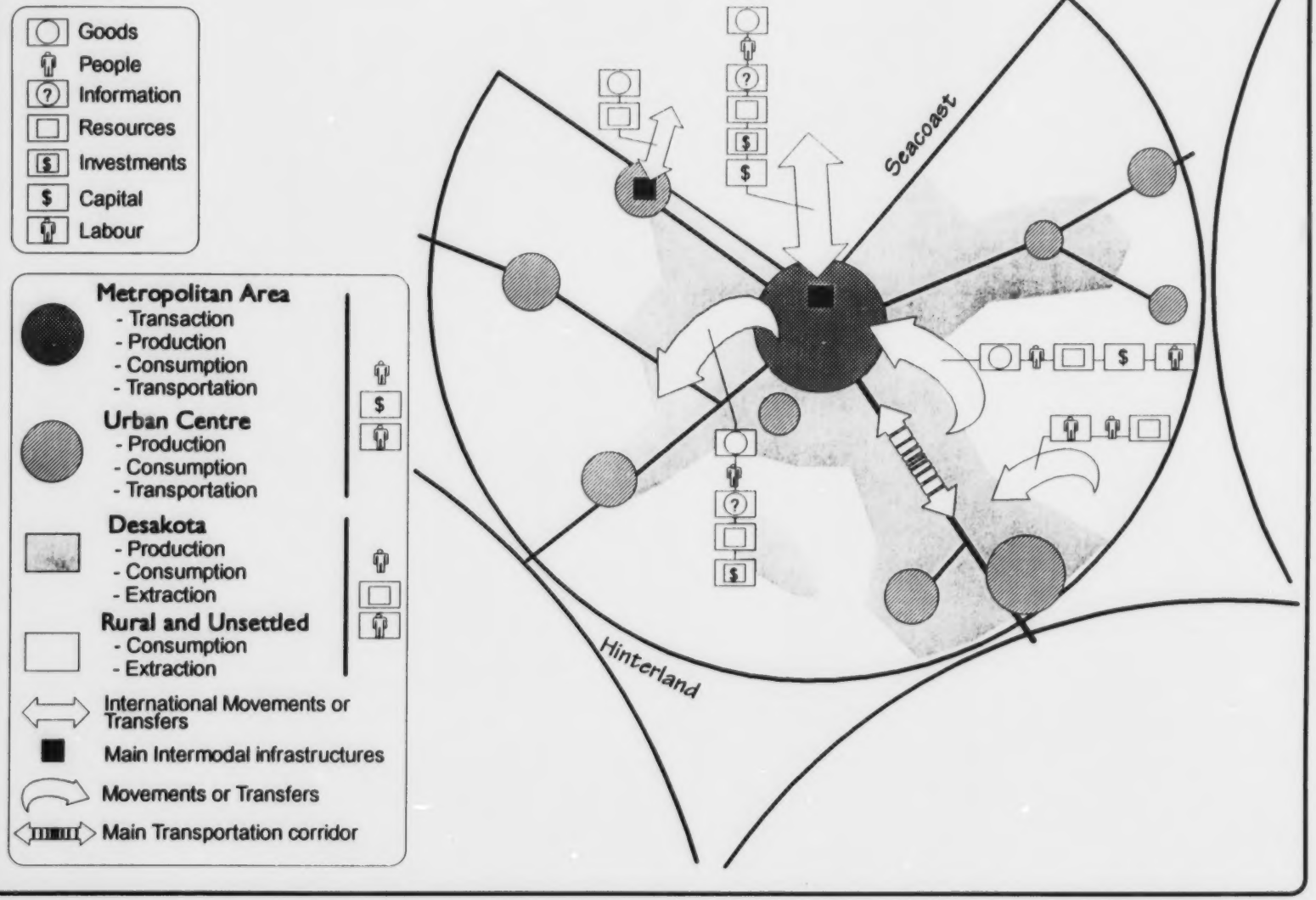
The economic development inside an EMR occur most of the time along a main transportation corridor. Historical factors has created an urban system along with initial transportation infrastructures. Current patterns of large scale urbanization are therefore oriented along the existing transportation corridor. This corridor gives an higher accessibility level to its surrounding space and thus favours movements of goods and people as well as investments. When that transportation corridor extend to another major metropolitan area, it is likely that the resulting economic area will form a mega-urban region.

Over the literature, the use of the concepts of mega-urban region and extended metropolitan region is not clear, and one is often confounded by the other (see Ginsburg, Koppel and McGee, 1991; Paderanga, 1990). We must understand that these are different scale of urbanization that are occurring in different spatial conditions. While mega-urban regions are largely observed in China where there is a developed and complex urban system of large cities, extended metropolitan regions could either represents a single metropolitan area within a mega-urban region of an unique case of a metropolitan centre extending its production and control over a territory. Singapore, along with Bangkok and Manila are such a spatial entities. Considering the less developed urban system in Southeast Asia, EMR is the only type of large scale urbanization occurring.

3.3 Spatial Transformations of Singapore Extended Metropolitan Region

The economic and spatial transformations of Singapore EMR can be understand within the following processes: 1) The emergence of Singapore as an international transportation hub for movements of goods, people and information resulting of heavy investments in transportation infrastructures. 2) The transformation of Singapore economical structures towards services and 'world city' activities, controlling a regional market. 3) The development

Extended Metropolitan Region: Spatial Pattern **Figure 3.2**



of a regional distribution and vertical integration of production complex to enhance the viability of the city's service sector and to compete in a newer global economy. Those processes have a strong influence on the densification, extension and transformation of the Singapore EMR.

3.3.1 Densification

The spatial accumulation of economic activities and infrastructures has been intense in Singapore over the 80s. While the population has only increased by 250,000 (+11.4%) from 1980 to 1990, bank assets have quadrupled (+302%) and gross domestic product have more than doubled (+150%). This means that the same economic entity is able to produce 2.5 more capital in 1990 than is was able to in 1980. It is not likely that this result can be achieved with the same production structure. Singapore is also investing in an efficient public transportation system that is extending towards Johor Baru (Varaprasad, 1989). Mobility have so increased that the authorities have restrained the use of cars and favoured public transit. This mode have a much higher capacity but is less flexible. With the same road surface, Singapore is able the cope the growth of mobility demand.

Table 3.1: Measures of Densification of Singapore, 1980-1990

Year	Population Density[1]	Value Added per Worker[3]	Built-up Area[1]	% of Total Area	Banks: Total Assets[2]	Gross Domestic Product[2]
1980	3,907	30,027	275.1	44.53	33,316.1	25,090.7
1985	4,122	42,436	298.8	48.15	70,618.0	38,923.5
1990	4,250	60,488	311.6	49.23	134,002.0	62,711.3

[1] In square kilometre (population per square kilometre for population density).
[2] In $ Million at current market prices.
[3] In dollars. This measure is for the manufacturing sector.
Source: Yearbook of Statistics, Singapore 1990, Department of Statistics, Singapore.

Table 3.1 shows several available measures of densification of Singapore over the 80s. Some spatial characteristics has remained relatively constant like the population density and the built-up area, but value added per worker, bank assets and the gross domestic product has showed an important increases. Those changes are the result of an important shift in the economy towards higher level of accumulation. The most important change is bank assets, which is strongly linked with the level of investment.

Table 3.2: Changes[1] in the Gross Domestic Product and Labour of Singapore by Industry, 1980-1990

Industry	1980		1985		1990		Δ% 80-90	
Agriculture & Fishing	1.28	(1.57)	0.75	(0.70)	0.28	(0.38)	-78.12	(-75.80)
Quarrying	0.33	(0.10)	0.29	(0.21)	0.13	(0.05)	-60.60	(-50.00)
Manufacturing	29.14	(30.05)	23.59	(25.45)	29.14	(28.39)	+0.00	(-5.52)
Utilities	2.21	(0.79)	2.04	(0.67)	1.98	(0.46)	-10.41	(-41.77)
Construction	6.43	(6.61)	10.71	(8.91)	5.61	(9.05)	-12.75	(+36.91)
Commerce	21.66	(21.28)	17.05	(23.49)	17.27	(22.02)	+3.48	(+3.48)
Transport & Communications	14.04	(11.15)	13.45	(10.17)	13.09	(9.42)	-6.77	(-15.52)
Financial & Business Services	19.70	(7.83)	27.37	(8.72)	32.80	(10.69)	+66.50	(+36.53)
Other Services	9.12	(20.58)	11.76	(21.51)	10.12	(19.54)	+10.96	(-5.05)
Total GDP[2] (Total Labour[3])	25,090.7 (1,073.4)		38,923.5 (1,154.3)		62,711.3 (1,485.8)		+149.94 (+38.42)	

[1] All statistics are in percentage. Labour is within parentheses.
[2] In $M at current market prices.
[3] In thousand persons.
Source: Yearbook of Statistics, Singapore 1990, Department of Statistics, Singapore.

Table 3.2 indicates that the agricultural sector is disappearing as a significant factor in the economy. The availability of land is scarce and land prices are very high. Agriculture cannot generate enough capital to justify its usage of land near Singapore. Manufacturing, as well as construction, commerce, transport and communication are stagnating. The greatest increases are within the financial, business services and other services sectors. This shows that a greater part of the economy is oriented towards the tertiary sector and that the secondary sector is stagnating. The growth of productivity of the financial and business services sector is underlined by the fact that labour force has grown by 36.53% while the part of the GDP has jumped by 66.50%. Drops in labour share in the manufacturing sector and a stagnation of its part of GDP suggests that the production is more technologically oriented, generating more capital with less labour. At a global scale, a raise of 38% of the total labour force was accompanied with a raise of 150% of the GDP, confirming that the same area is able to generate more capital. Those changes are generating a movement of "chain reaction" as the more densification is occurring, the more certain production activities are "expelled" towards the periphery.

3.3.2 Extension

The space / time collapse within the Singapore EMR can be understand with the rising accessibility of the Johore region and Riau to the Singapore intermodal centre and a drop in transportation costs. For instance, a newly established boat shuttle service link a Riau island (Batam) with Singapore in 30 minutes, while a new 1 billion S$ causeway linking Singapore to Johor is planned. Over the past, Singapore has successfully manage its internal transportation system (Pendakur, 1989; Varaprasad, 1989), and now Singapore is extending its transportation system at a regional level. Another important factor of extension is related to costs, mainly land and labour costs in areas adjacent to Singapore.

Table 3.3: Land and Labour Costs in Singapore, Johor and Batam, 1989

	Singapore	Johor	Batam
Land (US$/sq. metre)	4.25 (6.58)[1]	4.08	2.30
Labour (US$/month)			
Unskilled	350	150	90
Semi-skilled	420	220	140
Skilled	600	400	200

[1] Estimation for 1990.
Source: Lee, 1991, pp. 9.

Table 3.3 illustrate a comparison of costs between Singapore, Johor and Batam in 1989. Since the monthly rental rates for industrial and commercial properties increased by 55% in Singapore between 1989 and 1990, we estimated that the average land price in Singapore is around 6.58 US$ per square metre in 1990. It is likely that similar land value growths will occur over the 90s. The recent high growth of land price in Singapore is forcing labour-intensive industries to relocate and capital-intensive activities to settle in. With an average wage of 90 and 150 US$ a month in Batam and Johore respectively multinationals, can maintain knowledge-intensive operations in Singapore while relocating labour-intensive activities in Johor or Riau (Lee, 1991). This is a regional distribution of labour forming a single production unit scattered over a large territory.

3.3.3 Transformation

The restructuring of the Singapore economy towards a more transactional nature force certain activities to relocate outside the metropolitan area. In the Riaus, a island based transformation occur when investments are performed and labour is imported into scarcely populated islands where proximity to Singapore confer an high accessibility. For instance, the population of Batam, the nearest island from Singapore, has grown from 6,000 in 1973 to 106,800 in 1990 (table 3.4), a 1680% change. The transformation of the economic structure in Riau is mainly based in two sectors, leisure and agriculture, while Batam is more manufacturing oriented. Leisure is beach resort oriented and agriculture involve large scale production in agro-farms of specific food products for Singapore. From 1985 to 1990 the number of tourists in Batam have grown by 865%, confirming the fast development of the leisure sector.

Table 3.4: Indicators of Transformation in Batam, 1973-1990

	Population	Workers	Frequency of Flights	Ship Port Calls	Tourists
1973	6,000	NA	NA	NA	NA
1983	43,000	NA	481	5,029	NA
1985	58,000	6,400	1,545	5,592	60,161
1988	79,400	9,600	2,887	9,066	227,981
1989	90,500	11,200	3,511	10,258	359,497
1990	106,800	16,300	6,487	37,802	579,305

Source: Lee, 1991, pp. 82.

In 1990, the population of Johore was 2.2 million (12.4% of Malaysia), and Johor received 7.4% of total foreign investments in Malaysia. The industrial output of Johore has increased 25% from 1988 to 1990 and account for 28% of Malaysia GDP (11% in 1980). The industrial penetration occur mainly in industrial estates where foreign enterprises receive special advantages like tax reductions and use nearby labour pools. However, shortages of labour are already occuring, causing a raise in wages. In 1990, 27.0% of foreign investments came from Japan, 22.7% from Singapore and 13.7% from Taiwan. Even if the majority of investments do not came from Singapore, a great

part of the production of Johor must transit through the intermodal infrastructures of the city-state.

Table 3.5: Share of Johor for Foreign Direct Investments, 1990

Industry	of Malaysia	of Industrial Sector
Food Manufacturing	30.3	8.3
Textiles products	29.2	16.7
Wood products	9.0	7.5
Furniture	20.0	1.8
Paper, printing and publishing	7.6	4.1
Chemicals products	15.5	22.4
Petroleum and coal	0.9	1.4
Plastic products	8.5	2.2
Non-metallic mineral products	30.6	7.2
Basic metal products	0.9	3.9
Fabricated metal products	8.1	2.1
Machinery manufacturing	5.1	3.1
Electrical, electronic products	7.6	15.4
Transport equipment	15.4	2.5
Scientific equipment	10.0	0.4
Miscellaneous	11.7	0.9

Source: Lee, 1991, pp. 58-61.

Table 3.5 gives a sectoral breakdown of Foreign Direct Investments (FDI) for Johor in 1990. Nationally, Johor have received large shares of FDI in food manufacturing (30.3%), textiles (29.2%) and non-metallic mineral products (30.6%). Within Johor, FDI are mostly concentred in chemicals (22.4%), textiles (16.7%) and electrical and electronic products (15.4%). Therefore, the territorial transformation of Johor is oriented towards some specific labour intensive industrial sectors with strong linkages with Singapore as a gateway to the international market.

Figure 3.3 represents the spatial structure of Singapore EMR. The EMR can be divided in two distinct spatial systems: the continental and the seaboard. The continental system is a growth corridor starting from Singapore and extending in Malaysia towards Kuala Lumpur. Areas in transformation correspond to main road links. An highway will be builded along the main growth corridor, linking Singapore, Johore Baru and Kuala Lumpur. The growth corridor is not structured by the rail network. Most of movements are likely to use the road mode with small shipments with multiple points of origin and destination.

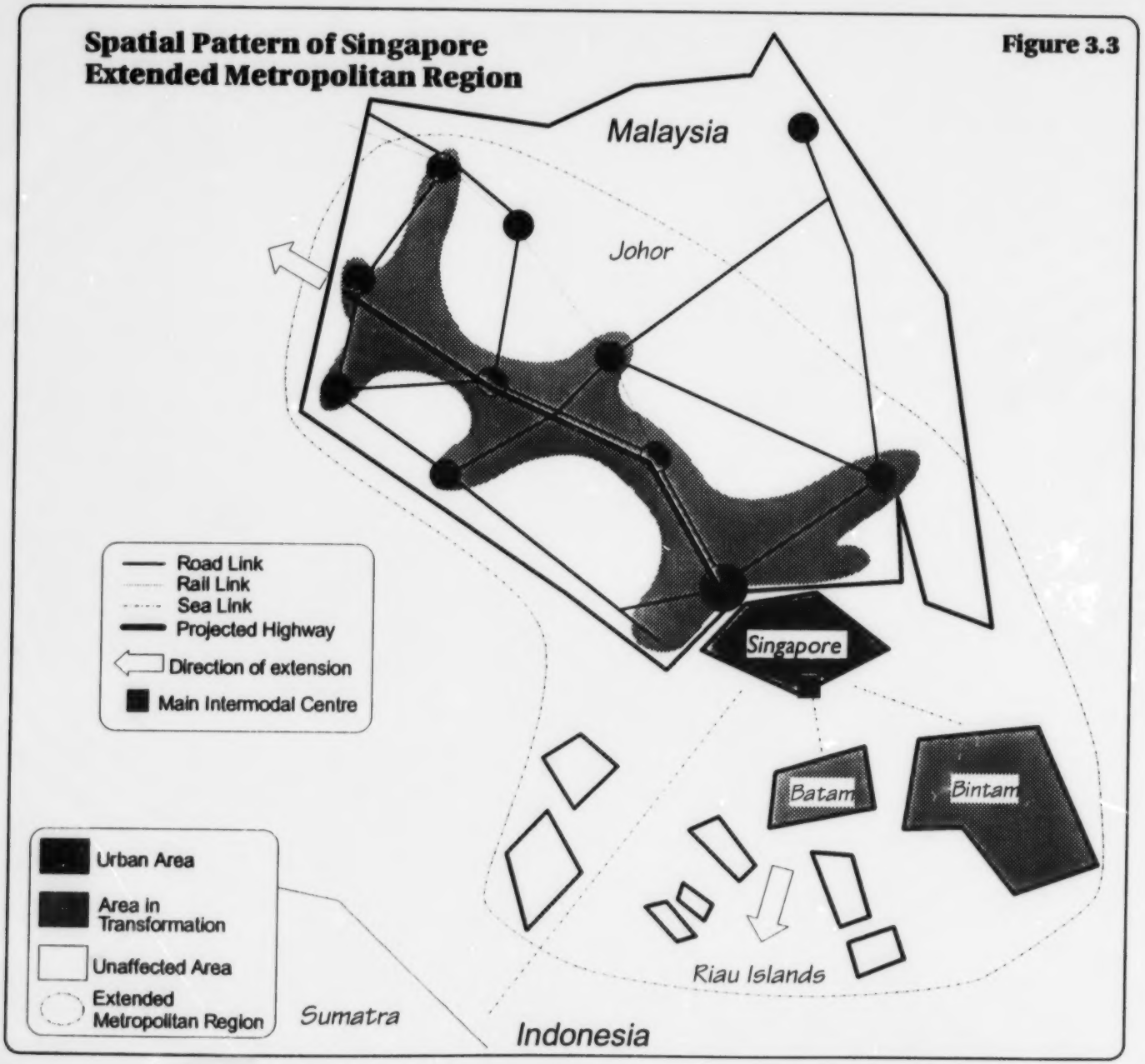
The seaboard system is multipolar because it is not constrained by land factors like topography and the presence of road transportation infrastructures. Areas in transformation are mainly Batam and Bintam islands that can be reached from Singapore within 30 to 45 minutes by ferry. For instance, the number of ship port calls have grown by 650% in Batam between 1983 and 1990 (see table 3.4). The EMR is rapidly extending toward the Riau Islands because of available land, imports of labour from Indonesia, and overall their high accessibility to Singapore intermodal centre.

4. Discussion

Territorial development (extension, densification and transformation) in the Singapore extended metropolitan region raise the following geographical questions: 1) What will be the spatial pattern resulting from large scale

Spatial Pattern of Singapore Extended Metropolitan Region

Figure 3.3



urbanization? 2) What kind of transportation / land use problems are likely to emerge? 3) Are there any planning strategies related to those problems?

4.1 Spatial Pattern

Road transportation favour a linear distribution of economic activities because roads are linear infrastructures, while intermodal transportation has a radial influence over space. This radial influence is the result of the location of intermodal infrastructures at specific point in space, that is a node. Since EMRs are a set of linear transportation infrastructures with nodes at radial intermodal centres, it is likely that corridors of economic development will emerge between main intermodal centres. Simple EMRs are likely to be composed of one transportation corridor, while a set of highly developed EMRs will form a mega-urban region or even a megalopolis characterized by several transportation corridors linking numerous intermodal points and forming a complex urban system. Past examples of developed urban forms like the BostWash and Tokaido megalopolises show that all transportation corridors are oriented along a main transportation axe giving an overall linear form to the urban system. A corridor of economic development is structured by major metropolitan centres that are at the same time the main intermodal centres.

The regional urban context of Singapore prevent the emergence, within a foreseeable future, of a complex urban system, that is a mega-urban region. The main reason is that Johore and the Riaus have a light population density. The spatial pattern of the Singapore EMR is likely to by linear and extending towards Kuala Lumpur. It also appear to be an island based developments towards Indonesia witch offers a high labour supply. The seaboard side of the Singapore EMR is likely to be multipolar, that is a set of production and leisure centres linked to Singapore by air and sea transportation. This type of island economic development is original and potentially highly productive because very few investments in transportation infrastructures are required. Islands offer numerous coastal areas where investment are performed, while the island mainland is most of the time disregarded. If the economic development of the region is dynamical enough, a mega-urban region could emerge with Singapore as the main intermodal centre. Singaporian authorities have advocated the notion of Growth Triangle to describe the emerging spatial pattern between Singapore, Johore and the Riaus (see Lee, 1991). Since Singapore is the only intermodal centre, the notion of Growth Triangle seams irrelevant because all movements going from the Riaus to Johore must past through Singapore. In that context, there is only a Growth Corridor with Singapore at the centre with Johore and the Riaus as peripheral extensions.

4.2 Transportation / Land Use Problems

One of the major land use problems of EMRs is that urban development often occur over highly productive rural areas, reducing at a regional level the cultivable land. This fact has high potential repercussions since Asian countries face strong demographic growth and limited development areas. EMRs are also characterized by fast unplanned development in rural areas where pollution control policies are nearly nonexistent, thus creating potential health problems and fast environmental degradation. For Singapore, environmental problems are likely to occur in Johor with rapid industrialization in rural areas and in the Riaus with the degradation of shores and marine life by the construction of resort complexes.

With the emergence of multiple types of economic activities in urban as well as in formerly rural areas, acute transportation problems are likely to appear. Cheap and available land with basic road transportation infrastructures are attractive to investments and tend to scatter economic activities over a large territory (extension). As the density of economic activities and the production level raise, so do the linkages. The result is multiple movements by road mode between several points of origin and destination. Transportation infrastructures that were initially sufficient, will soon become congested. Adding new transportation infrastructures will be a difficult task because very few areas will have a sufficient density of land use to justify investments. Scattered production is economical for individual investors (land price, labour, etc...), but expensive for the state and the society (congestion, pollution, external costs, etc...). Therefore, interactions between land use zones will be of great concern to planners trying to understand and order the territorial logic of those large urban regions.

4.3 Planning Strategies

Planning strategies involve economic and transportation development over a large territory with scattered units of production. There are a number of municipal, regional and even national governments involved, thus a

comprehensive planning scheme is highly problematic. If no "Extended Metropolitan Board" or any large scale administration agency is established, it is likely that contradiction in local policies will soon become a negative factor in development. Over that aspect, it is quite a challenge for Singapore since there are three national government involved; Singapore, Malaysia and Indonesia. A potential way to overcome overspread of economic activities is to concentrate most transportation investments along a linear corridor. A linear development is apt to favour a dynamic economic structure with limited transportation investments and covering a large territory with enough land for needs of development. This structure minimize transportation costs but must have a high capacity since most movements will occur along the corridor. Considering the needs for cultivable land, production activities and transportation infrastructures, especially road transportation, should be oriented along areas where the agricultural potential is lower. The overall problem is giving a sufficient level of accessibility to each land use zones, from agriculture to high technological production. In an EMR as well as in an inner city, planners must appraise growth in some areas and decline in others. What is new for an EMR is that declining areas could be given back to agricultural production. Another challenge lay in the development of the intermodal transportation system. Creating efficient intermodal nodes, like rail-road, at strategic locations along a linear transportation corridor could alleviate congestions and raise the capacity of the transportation system. However, this require a standardization of loads that containers already offers. This strategy is highly applicable to the Singapore EMR since the port of Singapore has a high handling capacity for containers.

5. Conclusion

Singapore is presently in a phase of integration of a large economic area including Johor province in Malaysia and the Riau Islands in Indonesia. Transportation is a key factor explaining three processes of territorial development in extended metropolitan regions, that is densification, extension and transformation. Densification is the result of a process of spatial accumulation of economic activities within an area. Extension is a space / time collapse enabling economic activities to extend over a large territory. Transformation is a process of change in rural activities towards urban oriented economic production system. We have suggested that nearly all the international trade generated inside the extended metropolitan region transit through Singapore. The main reason is that Singapore has invested in efficient intermodal infrastructures for people, goods and information. Container terminals are a good example of Singapore efficiency for intermodality in goods transportation. Considering the concentration level of transportation infrastructures, Singapore is likely to become the transportation platform of all South-East Asia thus controlling most of the trade and distribution of the spatial accumulation of capital.

Large scale urbanization is based on the growth of economic activities in a linear transportation corridor. However factors favouring the extension of urban space are also creating acute environmental as well as transportation problems. The extended metropolitan region is mostly an unplanned territory were the economic forces of the international market play an important role. If no planning policies are applied, it is likely that there is a high potential of territorial disintegration, that is the loss of the comparative advantages of scattered production units, and even more environmental degradation. The regional urban context of Singapore prevent the emergence, within a foreseeable future, of a complex urban system, that is a mega-urban region.

Bibliography

Castells, M. (1985) High Technology, Space and Society, Urban Affairs Annual Reviews, SAGE, Beverly Hills.

Comtois, Claude (1989) La transformation du littoral urbain: Application shanghaienne, Université de Montréal, Centre de Recherche sur les Transports, Publication #626.

Chia Lin Sien (1989) "The port of Singapore" in Sandhu, Kernial Singh and Paul Wheatley (eds) Management of Success: The Moulding of Modern Singapore, Institute of Southeast Asian Studies, Singapore, pp. 314-336.

Fesharaki, Fereidun (1989) "Singapore as an oil centre" in Sandhu, Kernial Singh and Paul Wheatley (eds) Management of Success: The Moulding of Modern Singapore, Institute of Southeast Asian Studies, Singapore, pp. 300-313.

Ginsburg, N., B. Koppel and T.G. McGee (eds) (1991) The Extended Metropolis: Settlement Transition in Asia, University of Hawaii Press, Hawaii.

Huth, M.J. (1983) "Toward a multi-nodal urban structure" Transportation Quaterly, Vol. 37, No. 2, pp. 245-262.

Lee Tsao Yuan (ed) (1991) Growth Triangle: The Johor-Singapore-Riau Experience, Institute of Southeast Asian Studies, Singapore, 119 pages.

McGee, T.G. (1991) "The emergence of desakota regions in Asia: Expanding a hypothesis" in Ginsburg, N., B. Koppel and T.G. McGee (eds) The Extended Metropolis: Settlement Transition in Asia, University of Hawaii Press, Hawaii, pp. 3-25.

Paderanga, C. jr. (1990) "The role of transport and infrastructure in the growth and expansion of mega-urban regions in Asia" Regional Development Dialogue, Vol. 11, No. 2, pp. 23-37.

Pendakur, V. Setty (1989) "Elaboration of the transport system" in Sandhu, Kernial Singh and Paul Wheatley (eds) Management of Success: The Moulding of Modern Singapore, Institute of Southeast Asian Studies, Singapore, pp. 399-419.

Rimmer, Peter J. (1986) "Japan's world cities: Tokyo, Osaka, Nagoya or Tokaido Megalopolis", Development and Change, Vol. 17, pp. 121-157.

Rolland-May, C. (1987) "La théorie des ensembles flous et son intéret en géographie", L'Espace Géographique, No. 1, pp. 42-50.

Sandhu, Kernial Singh and Paul Wheatley (eds) (1989) Management of Success: The Moulding of Modern Singapore, Institute of Southeast Asian Studies, Singapore, 1134 pages.

Singapore (1990) Yearbook of Statistics, 1990, Department of Statistics, 338 pages.

Thrall, Ian Grant (1987) Land Use and Urban Form: The Consumption Theory of Land Rent, Methuen, New York and London.

Varaprasad, N. (1989) "Providing mobility and accessibility" in Sandhu, Kernial Singh and Paul Wheatley (eds) Management of Success: The Moulding of Modern Singapore, Institute of Southeast Asian Studies, Singapore, pp. 420-435.